C. atlas — 3.5 kilometres south of the spring in mallee/spinifex.

C. schomburgkii — 3.5 kilometres south of the spring in mallee/spinifex.

**Lerista muelleri* — 8.0 kilometres north-west of Cundeelee Mission at 5 mile rockhole.

**Morethia butleri* — 3.5 kilometres south of the spring in a log in mallee/spinifex.

**Tiliqua rugosa* — one seen crossing the Zanthus-Cundeelee road.

**T. occipitalis* — 2.0 kilometres south of the spring in Callitris/mallee.

VARANIDAE

**Varanus gouldii* — 1.5 kilometres south of the spring in mallee/spinifex.

ELAPIDAE

**Furina diadema* — cat capture at Cundeelee Mission.

**Pseudonaja modesta* — Cundeelee Mission.

**Vermicella semifasciata* — 4.0 kilometres south of the spring on track at night.

A total of 24 species of reptile were recorded during this trip to Queen Victoria Spring, of which 11 species (those marked with an asterisk) have not previously been collected in this area. Several of the species collected are on the edge or just outside their known range as described by Cogger (1979). These include *Amphibolurus nuchalis*, *A. minor*, *Lerista muelleri*, *Diplodactylus strophurus* and *Furina diadema*.

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EXTRAFLORAL NECTARIES IN *ALYOGYNE HAKEIFOLIA* (GIORD.) ALEF. (MALVACEAE) AND THEIR ASSOCIATION WITH ANTS.

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ABSTRACT

Alyogyne hakeifolia possesses extrafloral nectaries which attract ants during the day and night. The extrafloral nectaries are associated with bracts on the stem, just below the flower. Nectar was never observed in the field but droplets formed when branches were kept at a low temperature. The extrafloral nectaries function throughout bud development, flowering and early maturity of the fruit. Bushes in the Kalbarri National

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Park were flowering in late November and all had ants present. On some plants the ants repelled attempts by humans to touch the flowers and foliage. However both the buds and flowers of all the plants showed signs of insect grazing which would prevent seed set. It is suggested that the presence of ants reduces the amount of destruction of the flowers. The extent to which this protection is effective probably depends on the species of ant.

INTRODUCTION

The most important function of extrafloral nectaries in plants is to provide an attraction for ants. The ants then protect the plant from grazing or other destructive insects. A number of recent studies have supported this hypothesis and point out the possibly co-evolved nature of the association (Bentley, 1977a, 1977b; Inouye and Taylor, 1979). The alternative view, that extrafloral nectaries have an excretory role, appears unlikely when the position of the nectaries on a number of plants is considered (Bentley, 1977a). Numerous examples of extrafloral nectaries have been described from outside Australia but few have been based on local native material.

During the 27th to 29th of November, 1979, I visited the Kalbarri National Park and the presence of ants on *Alyogyne hakeifolia* bushes was painfully brought to my notice when I attempted to examine the flowers. Here I describe my observations on the plants and the associated insects including ants. I also experimentally locate extrafloral nectar producing sites on the plants.

Fig. 1.—*A. hakeifolia* bud, flower and fruit (left to right). A = bracts at the summit of the pedicel. The whole ring of bracts is called an involucre. The ants appear to feed in the space between the bracts.

OBSERVATIONS ON THE PLANT — ANT ASSOCIATION

A. hakeifolia bushes in the Kalbarri National Park (27°45'S; 114°15'E) grow to two metres tall and have purple or white flowers with a small amount of purple at the base of the petals. The species appeared to be in the middle of its flowering phenology. Numerous ants were present on the buds, flowers, fruits and foliage of all of the 23 plants with purple flowers and all of the six plants with mostly white flowers. Neighbouring bushes of other species were devoid of ants. The ants appeared to be feeding at the junction of the bracts with the stem (Fig. 1). Other insects, including flies, butterflies, wasps, bees and beetles were also observed visiting this location on all white flowering and some purple flowering bushes but were considerably less abundant than the ants. No liquid or damage to the plant could be seen at the join of the bracts by using a hand lens (10 X magnification) and subsequent examination of branches with flowers by using a 60 X binocular microscope, also revealed no damage. Even under this magnification no distinct organ was seen near the bracts but hairs were present on the edge of the underside of the bracts and these could have a secretory function. In between visits the ants would move rapidly over the reproductive structures. None of the ants were nesting in the bushes nor were they observed damaging the plants.

PLANTS WITH PURPLE FLOWERS

Three bushes which were approximately half-way along Meenarra Drive, were occupied by an unidentified species of ant. This was the only insect observed. When people touched a bush, the ants swarmed onto the hand and commenced biting. Other bushes examined on Meenarra Hill and in the Kalbarri townsite had less aggressive and smaller ants. The smaller species (*Camponotus* sp. J.D.M. 63, *Iridomyrmex* sp. J.D.M. 9 and *I.* sp. J.D.M. 500†) would swarm onto the hand but did not bite. The bushes with the less aggressive ants also had other insects visiting the space between the bracts.

Four bushes in the Kalbarri townsite were observed at irregular intervals between 6.00 A.M. and 12.00 P.M. Ants were present at all times but no liquid was observed at the sites visited by ants.

There was considerable damage to the flowers. Signs of damage occurred on 87.8 ± 6.29% ($\bar{x}$ ± S.E.) of flowers. The sample was based on six to eleven flowers examined on each of seven plants in the Kalbarri townsite. The damage mainly occurred on the sepals but occasionally hall the petals were consumed. Stiles and stigmatic surfaces were also eaten. No insects were observed eating the plants but potential grazers such as grasshoppers were on neighbouring bushes. Insects were visiting the nectaries of open flowers but usually only two or three insects were present at any one time. The most frequently encountered insects in the flowers were adults of *Macroura* sp. (Coleoptera: Nitidulidae) which were never seen on the extrafloral nectaries. It is probable that the beetle is the pollinator of *A. hakeifolia*.

EXPERIMENT TO OBTAIN NECTAR

I suspected that the ants and other insects were attracted to nectar but the absence of the sweet liquid was probably due to a combination of feeding by insects and evaporation due to the high temperatures over the three days (*Min. 22-24° C; Max. 40-41° C).* The following method was used to obtain measurements of nectar. Branches from bushes with purple flowers on a vacant block in the Kalbarri townsite were removed by secateurs. Ants and other insects were removed from the branches. The branches were placed in sealed containers in the bottom of a house refrigerator and left over night. In the morning, nectar was observed as droplets between the bracts. Two samples, measured by using a Bellingham and Stanley Ltd. Refractometer, had 14% and 16% sucrose equivalents. The liquid also had a slightly sweet taste. Nectar was observed on nectaries of all stages from the buds through to the fruits. Even though the branches were cut I believe that the sugar measurements are more accurate than any attempts at field measurement due to the problem of evaporation. However the nectar may be slightly diluted as the sugars from other Malvaceae are thought to be hygroscopic (Butler *et al.*, 1972).

† Ant species codes refer to species in Dr. John D. Majer's collection housed at the Western Australian Institute of Technology.

DISCUSSION

Some of the plants of *A. hakeifolia* fit the ant protection classification of Bentley (1977b). The ants are aggressive and they forage all over the flower and foliage. The plants are vulnerable to herbivore attack, evidence of herbivore activity is present and nectar flow coincides with the time when floral and fruit parts are available for attack. However the ants were not aggressive on other plants but did swarm over humans when they touched the plants. It is possible that this activity would discourage herbivores. Some simple experiments, such as excluding the ants, would test if the presence of ants reduces the level of grazing.

It would be interesting to see if there is a difference in the extrafloral nectary function between the two colour forms of *A. hakeifolia*. Variation in nectary function is well known for the Malvaceae, especially in cotton (Bentley, 1977b) and variation in protection by ants can occur between habitats (Bentley 1976). Other questions, such as the interaction between pollinators and ants could also be examined. However the preliminary observations presented here, suggest that the pollinators and ants are visiting different nectaries. Another problem is the nutritional benefits the ants derive from the extrafloral nectaries on these plants. In the case of *A. hakeifolia* the nectar is only present when there are reproductive structures and the ants may have to rely on other sources of food in the non flowering season.

I am not aware of any previous description of extrafloral nectaries in *Alyogyne* and the genus was not examined in Janda's (1937) survey of extrafloral nectaries in the Malvaceae. Lewton (1915) states that the extrafloral nectary is a feature distinguishing *Alyogyne* from the other Australian Malvaceae but he does not describe their form or location on the plant. *A. hakeifolia* does have functioning extrafloral nectaries which are not obvious from a casual examination of the plant. It is probable that the hairs under the bracts are the secretory structures. Further work on the anatomy of this species would determine the actual location of the extrafloral nectaries.

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